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PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements relating to Fuel Injection Nozzles for Internal Combustion Engines including Gas Turbines

We, CLAYTON DEWANDRE COMPANY LIMITED, a British Company, of Titanic Works, Lincoln, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement—

This invention relates to fuel injection nozzles for internal combustion engines, including gas turbines.

In the majority of such nozzles the actual injection of the fuel is controlled by a differential needle valve formed with a conical valve face which co-operates with a correspondingly shaped valve seat surrounding an atomising orifice in the nozzle body, the valve being unseated by the fuel delivery pressure and reseated by a return spring. This arrangement, however, suffers a number of disadvantages. For example, its efficiency depends to a large extent upon the fit of the needle valve within its guide bore and of the valve face within the valve seat, and the finish of these parts consequently requires a great deal of precision and thus adds to the cost of their manufacture. Furthermore, the valve seat is not easily accessible, being at the blind end of the needle valve bore, and this tends to make its manufacture and maintenance somewhat difficult. In many cases, too, the return spring is disposed in the fuel ways leading to the atomising orifice, and its presence there produces undesirable dead space which is harmful in injection lines owing to the bulk modulus of the fuel.

The present invention aims to provide an improved fuel injection nozzle which avoids these disadvantages and is simple and cheap to produce.

According to the invention there is provided an improved fuel injection nozzle wherein the injection of the fuel is controlled by a non-return valve which is adapted to be unseated in the direction of the fuel flow by the fuel delivery pressure and to be reseated by a diaphragm or like flexible membrane formed with one or more atomising orifices through which the fuel is injected into the combustion space with which the nozzle is associated, characterised in that the nozzle comprises a cylindrical body portion which is recessed at one end to form a chamber in which the valve is mounted, and which is formed with a fuel supply passage opening into said chamber through an annular seating for the valve, the diaphragm being mounted across the recessed end of the body portion and being adapted to urge the valve onto said seating, and a hollow cylindrical member which fits over the body portion and has screw-threaded engagement therewith for clamping the diaphragm peripherally against the recessed end of said body portion, and which has a centrally apertured end wall adapted to form an abutment for the diaphragm to limit movement thereof.

Reference will now be made to the accompanying drawings which illustrate five embodiments of the invention in sectional elevation, Fig. 1 wholly and Figs. 2 to 5 fragmentarily.

In each of these embodiments, the nozzle consists of a cylindrical body 1 which fits concentrically within a cylindrical shell 2 formed with a hexagonal head *2a* and adapted to be screwed into the head or wall of the cylinder or other combustion space with which the nozzle is associated. The nozzle body 1 is secured in the shell by means of co-operating screw-threads 3 formed on the body and the shell. At its end the shell is formed with a wall 4 which has a central opening 5 and the inner face of which is dished slightly, as shown at 6, so as to leave a raised annular surface 7 around the periphery of said face.

The adjacent end of the nozzle body 1 is recessed to form a chamber 8 into which opens a fuel supply passage 9 extending axially through the nozzle body. Within this

[*Price 3s. 0d.*]

chamber there is mounted a non-return valve 10 which co-operates with an annular seating 11 formed around the end of the fuel supply passage 9 or the wall of the chamber 8. The valve is urged onto its seat by a diaphragm or like flexible membrane 12 which extends across the mouth of the chamber 8 and is peripherally clamped between the annular surface 7 on the inner face of the end wall of the shell 2 and a corresponding surface 13 on the adjacent end face of the nozzle body. In order to ensure an even contact between the valve and the diaphragm, the part of the valve against which the diaphragm bears is formed with a spherical surface.

The valve can take any one of a number of forms as shown in the accompanying drawings. In the embodiment shown in Fig. 1 the valve takes the form of a cone having a convex base 14 for contact with the diaphragm, and whose conical surface is adapted for engagement with the valve seat 11, which is correspondingly coned. In the embodiment shown in Fig. 2 the valve is constructed in the form of a cylinder having a coned valve face 15 at one end for engagement with the seating 11, which is correspondingly coned, and a spherical face 16 at the other end for contact with the diaphragm. Alternatively, as shown in Figs. 3 and 4, a ball valve can be employed, either in direct contact with the diaphragm (Fig. 3) or through the intermediary of a spacing member 17 (Fig. 4) formed with a concave recess 18 in which the ball valve sits. As shown in Fig. 5, a valve of the poppet type can also be employed, the stem 19 of the valve being guided in a cylindrical extension 8a of the chamber 8 and being formed with axial and radial passages 20 and 21 and a circumferential groove 22 for the passage of fuel. The head of the poppet valve is formed with a spherical face 23 for contact with the diaphragm. Whatever form the valve takes, the chamber 8 can readily be shaped so as to provide a guide for the valve in its opening and closing movements, should such a guide be necessary.

The diaphragm is formed with a central atomising orifice 24, as shown in Figs. 1, 2, 4 and 5, or with a number of orifices 25 spaced around its centre, as shown in Fig. 3, according to the required injection characteristics. If the diaphragm is formed with a single orifice at its centre it is necessary to provide passages and/or grooves in the valve on the downstream side of the valve seat 11 so as to ensure that the chamber 8 is at all times in free communication with the atomising orifice, since it is the central portion of the diaphragm that bears against the valve. In the embodiment shown in Fig. 1 this communication is provided by a diametral groove 26 formed in the convex base 14 of the valve; in Fig. 2 by passages 27 formed in the body of the valve and a diametral groove 28 in the spherical face 16 thereof; and in Fig. 5 by a diametral passage 29 formed in the head of the valve and an axial passage 30 opening out of the centre of the spherical face 23 of the valve. In the embodiment shown in Fig. 4 communication between the chamber 8 and the atomising orifice is ensured by providing the spacing member 17 with studs 31 which bear against the diaphragm away from the centre thereof and maintain a space 32 between the diaphragm and the adjacent face of the spacing member.

The operation of the nozzle in all of the above embodiments is as follows:—

Assuming the fuel supply passage 9 and the chamber 8 to be charged with fuel, at each operation of the nozzle the valve is unseated against the resistance of the diaphragm by the delivery pressure of the fuel pump, the pressure being transmitted through the fuel in the supply passage 9, and a quantity of fuel is consequently forced from the passage into the chamber 8 to cause a corresponding quantity of fuel to be discharged from the chamber through the atomising orifice or orifices in the diaphragm into the combustion space. At the end of each fuel delivery the diaphragm reseats the valve. Excessive flexing of the diaphragm is prevented by the end wall 4 of the shell 2. To provide an even abutment for the diaphragm the dished portion 6 of the inner face of this end wall can be shaped as a shallow cone, as shown in Fig. 2.

The advantages of the present invention can be seen from the foregoing description. For example, the valve and its seat are readily accessible, being located adjacent the end of the inner nozzle body, which facilitates considerably the manufacture and maintenance of the nozzle. Furthermore, the nozzle can be dismantled simply by unscrewing the inner nozzle body and removing it from the outer body, which also makes for ease of maintenance. Another advantage lies in the use of a diaphragm for biassing the valve onto its seat. By employing a diaphragm for this purpose instead of a return spring, and by using that diaphragm for the formation of the atomising orifice or orifices, the creation of undesirable dead space in the fuel ways leading to the atomising orifices is avoided.

What we claim is:—

1. A fuel injection nozzle wherein the injection of the fuel is controlled by a non-return valve which is adapted to be unseated in the direction of the fuel flow by the fuel delivery pressure and to be reseated by a diaphragm or like flexible membrane formed with one or more atomising orifices through which the fuel is injected into the combustion space with which the nozzle is

associated, characterised in that the nozzle comprises a cylindrical body portion which is recessed at one end to form a chamber in which the valve is mounted, and which is formed with a fuel supply passage opening into said chamber through an annular seating for the valve, the diaphragm being mounted across the recessed end of the body portion and being adapted to urge the valve onto said seating, and a hollow cylindrical member which fits over the body portion and has screw-threaded engagement therewith for clamping the diaphragm peripherally against the recessed end of said body portion, and which has a centrally apertured end wall adapted to form an abutment for the diaphragm to limit movement thereof.

2. A fuel injection nozzle according to Claim 1, wherein said member comprised a cylindrical shell formed with internal screw threads for engagement with screw threads on the body portion, and external screw threads for screwing into the head or wall of the combustion space.

3. A fuel injection nozzle according to Claim 2, wherein said end wall is recessed in its inner face to leave a raised annular surface for clamping the periphery of the diaphragm against a corresponding surface on the end face of said body portion surrounding the mouth of the chamber therein.

4. A fuel injection nozzle according to Claim 3, wherein the recess in the end wall of the shell is formed with a conical surface to provide said abutment for the diaphragm.

5. A fuel injection nozzle according to any one of Claims 1 to 4, wherein the diaphragm bears directly on the valve, and wherein, in order to ensure an even contact between the diaphragm and the valve, the part of the valve on which the diaphragm bears is formed with a spherical surface.

6. A fuel injection nozzle according to Claim 5, wherein the valve is constructed in the form of a cone having a convex base for contact with the diaphragm and whose conical surface forms the seating surface of the valve.

7. A fuel injection nozzle according to Claim 5, wherein the valve is constructed in the form of a cylinder having a coned seating surface at one end and a convex face at the other end for contact with the diaphragm.

8. A fuel injection nozzle according to Claim 5, wherein the valve is of the poppet type and has a convex face on its head for contact with the diaphragm.

9. A fuel injection nozzle according to Claim 6, 7 or 8, wherein the diaphragm is formed with a single atomising orifice at its centre, and wherein the valve is formed with passages and/or a groove or grooves on the downstream side of the valve seat to ensure free communication between the chamber and the atomising orifice.

10. A fuel injection nozzle according to any one of Claims 1 to 5, wherein the valve comprises a ball valve arranged in direct contact with the diaphragm at the centre thereof, and wherein the diaphragm is formed with a number of atomising orifices spaced from the centre of the diaphragm.

11. A fuel injection nozzle according to any one of Claims 1 to 4, wherein the valve comprises a ball valve and wherein the diaphragm is formed with a single atomising orifice at its centre, a spacing member being interposed between the ball valve and the diaphragm and being adapted to maintain free communication between the chamber and the atomising orifice.

12. A fuel injection nozzle constructed, arranged and adapted to operate substantially as herein described with reference to Fig. 1, 2, 3, 4 or 5 of the accompanying drawings.

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PROVISIONAL SPECIFICATION

Improvements relating to Fuel Injection Nozzles for Internal Combustion Engines

We, CLAYTON DEWANDRE COMPANY LIMITED, A British Company, of Titanic Works, Lincoln, do hereby declare this invention to be described in the following statement:—

This invention relates to fuel injection nozzles for internal combustion engines.

In the majority of such nozzles the actual injection of the fuel is controlled by a differential needle valve formed with a conical valve face which co-operates with a correspondingly shaped valve seat surrounding an atomising orifice in the nozzle body, the valve being unseated by the fuel delivery pressure and reseated by a return spring. This arrangement, however, suffers a number of disadvantages. For example, its efficiency depends to a large extent upon the fit of the needle valve within its guide bore and of the valve face within the valve seat, and the finish of these parts consequently requires a great deal of precision and thus adds to the cost of their manufacture. Furthermore, the valve seat is not easily accessible, being at the blind end of the needle valve bore, and this tends to make its manufacture and

maintenance somewhat difficult. In many cases, too, the return spring is disposed in the fuel ways leading to the atomising orifice and its presence there produces undesirable dead space which is harmful in injection lines owing to the bulk modulus of the fuel.

The present invention aims to provide an improved fuel injection nozzle which avoids these disadvantages.

According to the invention there is provided an improved fuel injection nozzle wherein the injection of the fuel is controlled by a non-return valve mounted in a chamber in the body of the nozzle, the valve being adapted to be unseated in the direction of the fuel flow by the fuel delivery pressure and to be reseated by a diaphragm or like flexible membrane formed with one or more atomising orifices through which the fuel is injected from the chamber into the combustion space with which the nozzle is associated.

In carrying the invention into effect according to a preferred form thereof the improved nozzle consists of inner and outer cylindrical nozzle bodies of which the outer body is hollow to receive the inner body. The latter fits concentrically within the outer body and is secured therein by means of co-operating screw-threads formed on the two bodies. The outer body is formed at one end with a wall which has a central opening and the inner face of which is dished slightly so as to leave an annular raised portion around the periphery thereof.

The adjacent end of the inner nozzle body is recessed to form a chamber into which opens a fuel supply passage extending axially through the inner nozzle body. Within this chamber there is mounted a non-return valve which co-operates with an annular seating formed around the end of the fuel supply passage or the wall of the chamber. The valve is urged onto its seat by a diaphragm or like flexible membrane which extends across the mouth of the chamber and is peripherally clamped between the annular surface of the raised portion on the inner face of the end wall of the outer nozzle body and a corresponding surface on the adjacent end face of the inner nozzle body. The diaphragm is formed with a central atomising orifice or with a number of orifices spaced around its centre according to the required injection characteristics.

Assuming the fuel supply passage and the chamber to be charged with fuel, at each operation of the nozzle the valve is unseated by the delivery pressure of the fuel pump, the pressure being transmitted through the fuel in the supply passage, and a quantity of fuel is consequently forced from the passage into the chamber to cause a corresponding quantity of fuel to be discharged from the chamber through the atomising orifice or orifices into the combustion space. If the diaphragm is formed with a single orifice at its centre it is necessary to provide passages and/ or grooves in the valve on the downstream side of the valve seat so as to ensure that the chamber is at all times in free communication with the atomising orifice, since it is the central portion of the diaphragm that bears against the valve. In order to ensure an even contact between the valve and the diaphragm, the part of the valve against which the diaphragm bears is formed with a spherical surface.

The valve can take any one of a number of forms. For example, it can be constructed in the form of a cylinder having a coned valve face at one end for engagement with the valve seat, which is correspondingly coned, and a spherical face at the other end for contact with the diaphragm. Alternatively, a ball valve can be employed, either in direct contact with the diaphragm or through the intermediary of a spacing member formed with a concave recess in which the ball valve engages. The valve can also take the form of a cone having a convex base for contact with the diaphragm, and the conical surface of which is adapted for engagement with the valve seat which is correspondingly coned. A valve of the poppet type can also be employed, the stem of the valve being guided in a cylindrical extension of the chamber.

Whatever form the valve takes, the chamber can readily be shaped so as to provide a guide for the valve in its opening and closing movements.

The advantages of the present invention will be apparent from the foregoing description. For example, the valve and its seat are readily accessible, being located adjacent the end of the inner nozzle body, which facilitates considerably the manufacture and maintenance of the nozzle. Furthermore, the nozzle can be dismantled simply by unscrewing the inner nozzle body and removing it from the outer body, which also makes for ease of maintenance. Another advantage lies in the use of a diaphragm for biassing the valve onto its seat. By employing a diaphragm for this purpose instead of a return spring, and by using that diaphragm for the formation of the atomising orifice or orifices, the creation of undesirable dead space in the fuel ways leading to the atomising orifices is avoided.

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760,852 COMPLETE SPECIFICATION

1 SHEET

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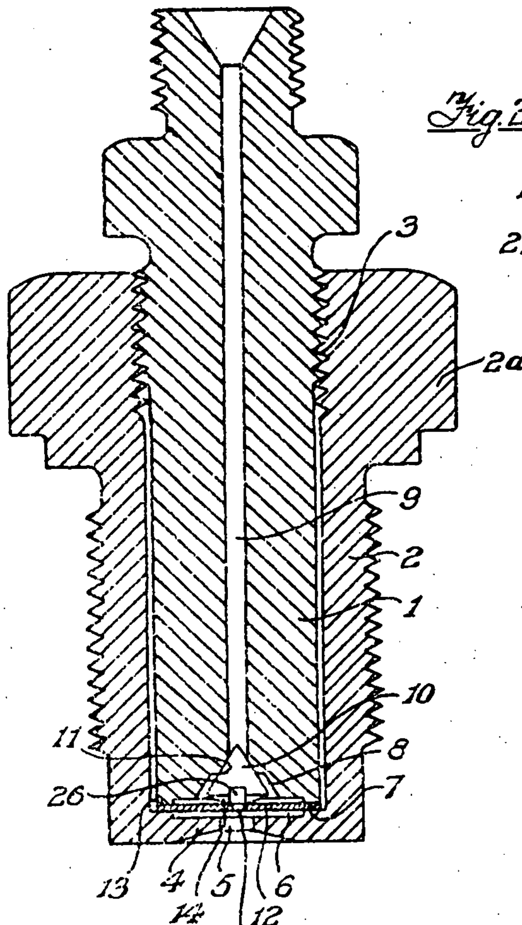

Fig.1.

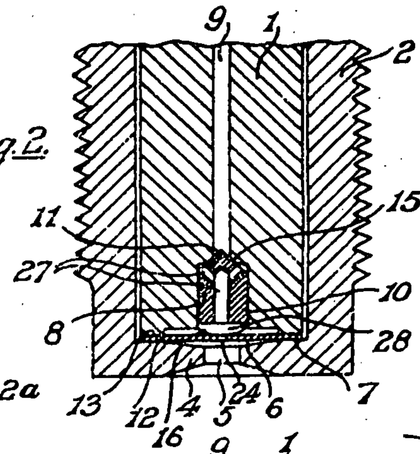

Fig.2.

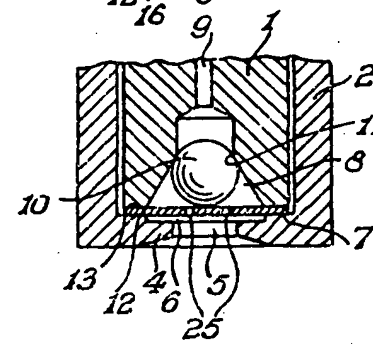

Fig.3.

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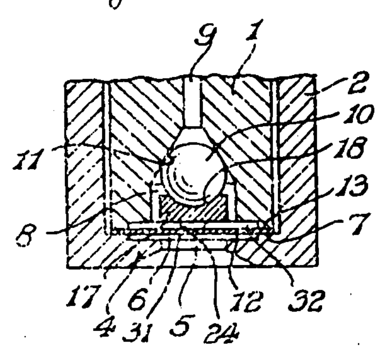

Fig.4.

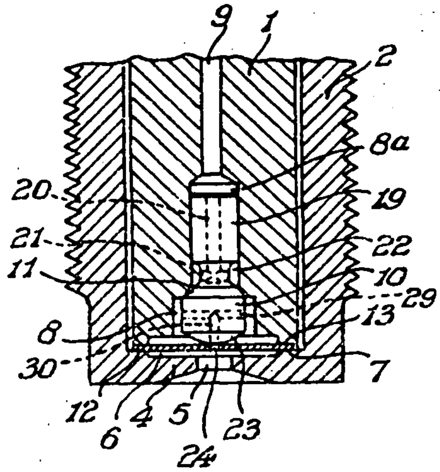

Fig.5.